UNITED STATES PATENT APPLICATION

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FOR

METHOD OF DATA RATE EXCHANGE FOR TRANSMISSIONS ACROSS A PACKET-BASED NETWORK

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METHOD OF DATA RATE EXCHANGE FOR TRANSMISSIONS ACROSS A PACKET-BASED NETWORK

BACKGROUND OF THE INVENTION

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1. Field of the Invention

This invention generally relates to the field of data communication systems. More particularly, the invention presents an improved method for exchanging data rate information across a packet-based network.

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2. Priority Information

The present application claims domestic priority, under 35 U.S.C. § 119(e), based on U.S. Provisional Application No. 60/211,821, filed by the same inventive entity, Jovanovic *et al.*, on June 15, 2000, entitled "Procedure for Data Rate Exchange of Data/Fax Transmission 15 Across a Packet-Based Network."

3. Description of Related Art and General Background

With the unprecedented growth of the Internet, as well as the advances in computer technologies, the Public Switched Telephone Network (PSTN) has evolved into a main 20 communication infrastructure for data traffic. Customer premise equipment (CPE) having communication capabilities, such as, for example, facsimile machines and modems, are now prevalent in both homes and offices. More often than not, CPEs rely on the PSTN infrastructure to provide connectivity to remote locations and support data traffic transport.

FIG. 1A depicts the conventional transport of data traffic across PSTN **108**. As indicated in FIG. 1A, local CPE **102A** and remote CPE **102B** are respectively coupled by local access (i.e., local loop) to a telephone service provider's central switching office (CO) **104A, 104B**. CPEs **102A, 102B** are equipped with dial-up communication capabilities to

5   initiate and establish connectivity. These capabilities operate in accordance with well-known communication protocols, such as, for example, ITU-T V series fax/data modem protocols, and in particular the V.34, *Series V: Data Communication Over the Telephone Network*, published in February 1998, the contents of which are herein expressly incorporated by reference. The V.34 protocol provides for the modulation, on-hook/off-hook, hand-shaking,

10   and control signaling operations over PSTN **108**.

Typically, a local CPE **102A** initiates connectivity by dialing to remote CPE **102B**, which accesses a switching mechanism in the local CO **104A**. The local switching mechanism establishes an inter-office trunk connection to a remote switch in the remote CO **104B** corresponding to the dialed remote CPE **102B**. Upon achieving connectivity between

15   the local CPE **102A** and remote CPE **102B**, a continuous, dedicated, circuit-switched, fixed channelized bandwidth is established for the duration of the call.

If the local and remote CPEs **102A, 102B** are facsimile machines, the digital data scanned from the imaging portion is then modulated in an analog form suitable for transmission across the local loop wires and ultimately conveyed to the dialed facsimile

20   machine. The transmission between the local CPE **102A** and the remote CPE **102B** operates in half-duplex mode. Similarly, if the local and remote CPEs **102A, 102B** are modems, the digital data received from a connected computer is then modulated in an analog form suitable

for transmission across the local loop wires and ultimately conveyed to the dialed modem. In such a case, the transmission between the local CPE **102A** and the remote CPE **102B** operates in full-duplex mode.

There are, however, drawbacks in the use of PSTN **108** to accommodate data traffic. For example, performance problems arise because data calls do not use the voice bandwidth efficiently. Data traffic tends to be bursty in nature and most of the time a data connection is not actually transmitting data, it is simply reserving the connection in case it might use it. In addition, PSTN **108** was designed with the assumption that a relatively short call set-up time would be followed by a large amount of voice data being transferred. However, for data transfers, the call set-up time in the PSTN **108** is very long relative to the length of the individual data transfers. This is exacerbated by the fact that, in order to minimize latency caused by call set-up times, most users leave their telephone connections off-hook for the entire time of the session, which may last several hours.

In an effort to alleviate some of these performance issues, telephone service providers have developed Packet-Based Networks (PBN) on top of the PSTN **108** infrastructure to handle data traffic. FIG. 1B illustrates the conventional transport of data traffic across PBN **110**.

As depicted in FIG. 1B, local CPE **102A** and remote CPE **102B** are respectively coupled by local access to local and remote COs **104A**, **104B**. In turn, local and remote COs **104A**, **104B** are coupled to local and remote gateway mechanisms (GWs) **106A**, **106B**, via PSTN **108A**, **108B**, respectively. Local and remote GWs **106A**, **106B** are configured to

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demodulate the analog data traffic received from the local and remote COs **104A, 104B** into

digital data and redirect the digital data to PBN **110**.

Prior to conveying the digital data over the PBN **110**, communication protocols, such

as, for example, the aforementioned V.34 protocol, establish a local communications session

5   between the local CPE **102A** and local GW **106A** and a remote communications session

between the remote CPE **102B** and remote GW **106B**. In order to ensure proper operation and

data transfer between the respective CPEs **102A, 102B** and GWs **104A, 104B**, these local and

remote sessions include various handshaking, negotiation, and training procedures (e.g., V. 34

Phase 2, Phase 3).

10   In particular, the V.34 protocol provides for the exchange of information sequences

between the local CPE **102A** and GW **106A** and the remote CPE **102B** and GW **106B** during

start-up, re-training, and re-negotiation sequences. These information sequences reflect the

capabilities of, and the modulation parameters (e.g., MP, MP_h sequences) supported by, the

local and remote CPEs **102A, 102B** and the local and remote GWs **104A, 104B**. Embedded

15   in the modulation parameter sequences, are the maximum data signaling rate supported by the

local and remote CPEs **102A, 102B** and the local and remote GWs **106A, 106B**.

As such, prior to establishing the local and remote sessions, the maximum data

signaling rates between the local CPE **102A** and GW **106A** and between the remote CPE

102B and GW **106B** are exchanged and negotiated in order to determine the most suitable

20   data signaling rates. There exists the possibility, however, that the most suitable data

signaling rate between the local CPE **102A** and GW **106A** and the most suitable data

signaling rate between the remote CPE **102B** and GW **106B** may be incompatible. At best,

such incompatibility may result in sub-optimal data transmission performance. At worst, such

incompatibility may result in the loss of data.

SUMMARY OF INVENTION

5   Methods and apparatuses consistent with the principles of the present invention, as

embodied and broadly described herein, provide for a method of exchanging source-to-sink

data rate information across a packet-based network. The method includes receiving, by a

first gateway mechanism coupled to said network, data rate information from a first

communication device that is configured to operate as a source, sink, or both. The method

10   then determines a first data signaling rate between the first communication device and the first

gateway mechanism. Similarly, a second gateway mechanism receives data rate information

from a second communication device that is also configured as a source, sink, or both. The

method then determines a second data signaling rate between the second communication

device and the second gateway mechanism. The first gateway mechanism forwards the data

15   rate information containing the first data signaling rate to the second gateway mechanism and

the second gateway mechanism forwards the data rate information containing the second data

signaling rate to the first gateway mechanism. The first communication device and the first

gateway mechanism determine a maximum compatible source-to-sink data rate based on the

first data signaling rate and the second data signaling rate received from the second gateway

20   mechanism. The second communication device and the second gateway mechanism

determine a maximum compatible source-to-sink data rate based on the second data signaling

rate and the first data signaling rate received from the first gateway mechanism.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1A depicts a functional block diagram of a PSTN-based communication system.

5   FIG. 1B depicts a functional block diagram of a PBN-based communication system.

FIG. 2 depicts a signal flow diagram, constructed and operative in accordance with an embodiment of the present invention.

FIG. 3 depicts a flowchart, illustrating an example operation of an embodiment of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

The following detailed description refers to the accompanying drawings that illustrate embodiments of the present invention. Other embodiments are possible and modifications may 15 be made to the embodiments without departing from the spirit and scope of the invention. Therefore, the following detailed description is not meant to limit the invention. Rather the scope of the invention is defined by the appended claims.

According to an embodiment of the present invention, as indicated in FIG. 2, a first (or local) communication device transmits modulation parameter information containing data 20 signaling rate information to a first (or local) gateway mechanism. Similarly, a second (or remote) communication device transmits modulation parameter information containing data signaling rate information to a second (or remote) gateway mechanism. The data signaling

rate information for both the first and second communication devices represents the source-to-sink data rate. After determining the compatible data rate with the first communication device, the first gateway mechanism accordingly transmits the modulation parameter information to the second gateway mechanism. Similarly, after determining the compatible

5   data rate with the second communication device, the second gateway mechanism commensurately transmits the modulation parameter information to the first gateway mechanism.

Upon receiving the modulation parameter information from the second gateway mechanism, the first gateway mechanism determines the maximum compatible source-to-sink

10   data rate and accordingly sends the modulation parameter information to the first communication device. The sent modulation parameter information will be used to determine a compatible data signaling rate that takes into consideration the capabilities of the first communication device, the first gateway mechanism, the second communication device, and the second gateway mechanism. In like fashion, after receiving the modulation parameter

15   information from the first gateway mechanism, the second gateway mechanism determines the maximum compatible source-to-sink data rate and accordingly sends the modulation parameter information to the second communication device. The sent modulation parameter information will be used to determine a compatible data signaling rate that takes into account the capabilities of the second communication device, the second gateway mechanism, the first

20   communication device, and the first gateway mechanism.

In this manner, the first and second gateway mechanisms are forced to wait until they receive modulation parameter information from each other before settling on a source-to-sink

data rate. By doing so, the present invention ensures that a compatible source-to-sink data rate will be achieved between the first and second communication devices, thereby minimizing the possibility of lost data.

It is to be noted, that the terms "local" and "remote" will be used to simplify the
5   foregoing description of the embodiments of the present invention. It will be appreciated that, because communication devices may transmit data in half- or full-duplex mode, use of the terms "local" and "remote" are not intended to infer half- or full-duplex operations unless expressly indicated otherwise.

FIG. 3 illustrates process **300**, constructed to provide the exchange of data rate information across a packet-based network, in accordance with the present embodiment. As
10   indicated in block **B355**, and in compliance with the V.34 protocol, the data signaling rates are negotiated during the start-up, retrain, and rate re-negotiation sequences. In block **B360A**, the local CPE **102A** receives modulation parameter signals, indicative of the local data signaling rate information, from the local GW **106A**. The local data signaling rate information includes information regarding the rates supported by the local CPE **102A**. As noted in FIG. 2, the data
15   signaling rate information from the local CPE **102A** may be represented by **MP**$_{AC}$.

Similarly, in block **B360B**, the remote GW **106B** receives modulation parameter signals, indicative of the remote data signaling rate information, from the remote CPE **102B**. The remote data signaling rate information includes information regarding the rates supported by the remote CPE **102B**. As noted in FIG. 2, the data signaling rate information from the remote CPE **102B**
20   may be represented by **MP**$_{BC}$.

In block **B365A**, process **300** determines a local data signaling rate d_A. Local data signaling rate d_A represents the maximum local data signaling rate that may be supported by both the local CPE **102A** and local GW **106A**. Local data signaling rate d_A may be captured and stored in local data signaling rate information **MP$_A$**. In like fashion, in block **B365B**, process **300** determines a remote data signaling rate d_B. Remote data signaling rate d_B represents the maximum remote data signaling rate that may be supported by both the remote CPE **102B** and remote GW **106B** and may be captured and stored in remote data signaling rate information **MP$_B$**. The determination of data signaling rate d_B may occur after the determination of data signaling rate d_A, although other interactions between the remote CPE **102B** and remote GW **106B** may be concurrent to the interactions between the local CPE **102B** and local GW **106B**

In block **B370A**, process **300** directs the forwarding of **MP$_A$** from the local GW **106A** to the remote GW **106B**. As noted in FIG. 2, **MP$_A$** is forwarded to remote GW **106B**. This ensures that the remote CPE **102B** and GW **106B** possess data signaling rate information about the local CPE **102A** and GW **106A**, prior to establishing a compatible end-to-end data signaling rate. Similarly, in block **B370B**, process **300** directs the forwarding of **MP$_B$** from the remote GW **106B** to the local GW **106A**. This ensures that the local CPE **102A** and GW **106A** possess data signaling rate information about the remote CPE **102B** and GW **106B**, prior to establishing a compatible data signaling rate.

In block **B375A**, process **300** determines whether local GW **106A** has received the remote data signaling rate information **MP$_B$** from remote GW **106B**. If GW **106A** has received **MP$_B$**, process **300** advances to block **B385A**. If GW **106A** has not received **MP$_B$**, process **300**, in block **B380A**, delays the further processing of GW **106A** until GW **106A** receives **MP$_B$**. Such

delay may be achieved by implementing non-functional modulation parameter signals or similar innocuous transactional signals, until the receipt of MP_B is confirmed by GW **106A**.

Likewise, in block **B375B**, process **300** determines whether remote GW **106B** has received the local data signaling rate information MP_A from local GW **106A**. If GW **106B** has received MP_A, process **300** advances to block **B385B**. If GW **106B** has not received MP_A, process **300**, in block **B380B**, delays the further processing of GW **106B** until GW **106B** confirms the receipt of MP_A.

If local GW **106A** has received MP_B, process **300**, in block **B385A**, determines a maximum source-to-sink data signaling rate d_{MAX} that is compatible with the remote data signaling rate d_B as well as the received local data signaling rate d_A included in MP_B. In like fashion, process **300**, in block **B385B**, determines a maximum source-to-sink data signaling rate d_{MAX} that is compatible with the remote data signaling rate d_B as well as the received local data signaling rate d_A included in MP_A. By doing so, process **300** ensures that the determined maximum source-to-sink data signaling rate d_{MAX} is compatible at both ends of the packet-based network **110**, thereby minimizing the possibility of lost data.

In block **B390A**, process **300** directs the local GW **106A** to send modulation parameter information to the local CPE **102A**. The modulation parameter information conveyed to the local CPE **102A** includes d_{MAX} as well as other information regarding the capabilities of local GW **106A** (indicated by MP_{AG} in FIG. 2) and remote CPE **102B** (i.e., MP_B). Similarly, process **300**, in block **B390B**, directs the remote GW **106B** to send modulation parameter information to the remote CPE **102B**, which includes d_{MAX} as well as local GW **106A** (indicated by MP_{BG} in FIG. 2) and remote CPE **102B** (i.e., MP_B) capabilities.

Finally, in block **B395**, process **300** allows for data transfers to occur between the local CPE **102A** and remote CPE **102B** at the maximum compatible source-to-sink data signaling rate d_{MAX}.

It will be appreciated that for half-duplex transmissions, such as in the case of CPEs 5 **102A**, **102B** configured as facsimile machines, the maximum compatible source-to-sink data signaling rate d_{MAX} achieved by process **300** may be used by both CPEs **102A**, **102B**. That is, during the time interval when CPE **102A** operates as a source, CPE **102A** transmits to CPE **102B** at d_{MAX} and during the time interval that CPE **102B** operates as a source, CPE **102B** transmits to CPE **102A** at d_{MAX}.

It will also be appreciated that for full-duplex transmissions, such as in the case of CPEs 10 **102A**, **102B** configured as modems, process **300** may be used to possibly determine two values for d_{MAX} (i.e., d_{MAXA} and d_{MAXB}). Because CPEs **102A**, **102B** both operate as sources and sinks concurrently during full-duplex operations, the maximum compatible source-to-sink data signaling rate d_{MAX} when CPE **102A** transmits to CPE **102B** may be different than the maximum compatible source-to-sink data signaling rate d_{MAX} when CPE **102B** transmits to CPE **102A**. As 15 such, process **300** may be used to determine one value when CPE **102A** transmits to CPE **102B** (i.e., d_{MAXA}) and process **300** may be used to determine another value when CPE **102B** transmits to CPE **102A** (i.e., d_{MAXB}).

It will be apparent to one of ordinary skill in the art that the embodiments as described 20 below may be implemented in many different embodiments of software, firmware, and hardware in the entities illustrated in the figures. The actual software code or specialized control hardware used to implement the present invention is not limiting of the present

invention. Thus, the operation and behavior of the embodiments will be described without specific reference to the actual software code or specialized hardware components. The absence of such specific references is feasible because it is clearly understood that artisans of ordinary skill would be able to design software and control hardware to implement the

5   embodiments of the present invention based on the description herein.

Moreover, the processes associated with the presented embodiments may be stored in any storage device, such as, for example, non-volatile memory, an optical disk, magnetic tape, or magnetic disk. Furthermore, the processes may be programmed when the system is manufactured or via a computer-readable medium at a later date. Such a medium may include

10   any of the forms listed above with respect to storage devices and may further include, for example, a carrier wave modulated, or otherwise manipulated, to convey instructions that can be read, demodulated/decoded and executed by the system.

The foregoing description of the preferred embodiments is provided to enable any person skilled in the art to make or use the present invention. Various modifications to these

15   embodiments are possible, and the generic principles presented herein may be applied to other embodiments as well. For example, the invention may be implemented in part or in whole as a hard-wired circuit, as a circuit configuration fabricated into an application-specific integrated circuit, or as a firmware program loaded into non-volatile storage or a software program loaded from or into a data storage medium as machine-readable code, such code

20   being instructions executable by an array of logic elements such as a microprocessor or other digital signal processing unit.

As such, the present invention is not intended to be limited to the embodiments shown above but rather is to be accorded the widest scope consistent with the principles and novel features disclosed in any fashion herein.